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Biostratigraphic and Lithostratigraphic Analysis of the Hindsville Limestone (Mississippian) in Northwestern Arkansas

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ABSTRACT

Several lithofacies can be recognized within the Hindsville Limestone (Mississippian) in its type area near Hindsville, Madison County, Arkansas. Lithofacies are based on petrographic analysis of matrix and constituent particles, particularly ooliths and skeletal grains. Hindsville deposition began with skeletal calcilutite incorporating chert rubble from the underlying Boone Formation. Increasing energy produced a sequence of skeletal calcarenites and oolites, and the end of Hindsville deposition was marked by a return to impure skeletal calcilutite.

Conodonts recovered from the Hindsville Limestone include species of *Cavusgnathus* and *Gnathodus*. On the basis of reported ranges of these elements, the Hindsville appears to correlate with part of the Middle Chesterian Series in its type region.

INTRODUCTION

Purdue and Miser (1916) named the Hindsville Limestone as a member of the Batesville Formation for exposures of chert-bearing, oolitic limestone in the vicinity of Hindsville, Madison County, Arkansas. In this area, the Hindsville disconformably overlies the Boone Formation and is overlain by the Fayetteville Shale (Fig. 1). Subsequent workers have disagreed as to stratigraphic rank and correlation of Hindsville strata in northern Arkansas. Ogren (1968) regarded the Hindsville as a shelf facies laterally equivalent to the Batesville Formation, whereas Garner (1967) favored informal recognition of the Hindsville as isolated carbonate mounds within the predominantly terrigenous Batesville Sandstone. This unit has been accorded formational status by workers in Missouri (Howe and Koenig, 1961) and Oklahoma (Huffman, 1958). Lower to Middle Chesterian correlations have been suggested for the Hindsville on the basis of brachiopods (Croneis, 1930), goniatites (Drahovzal, 1972; Furnish and Saunders, 1971) and conodonts (Thompson, 1972).

The differing reports of the stratigraphic rank and correlation of the Hindsville have necessitated a detailed lithostratigraphic and biostratigraphic analysis of this unit in northern Arkansas. A type section was not designated for the Hindsville by Purdue and Miser (1916). Therefore, a relatively well exposed section in the type area serves as the subject for this report and as the primary reference section for a comprehensive investigation of the Hindsville Limestone in northern Arkansas (Grayson, in preparation).

Location. Hindsville Sink Section — SW¼ SW¼ NE¼ Sec. 17, T17N, R27W, Madison County, Arkansas.

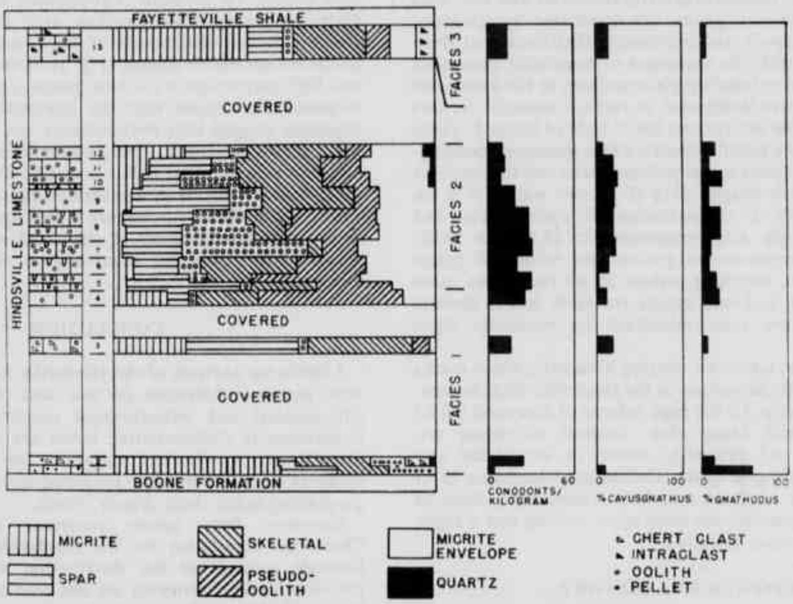

Figure. 1. Variation in lithology and conodont abundances, Hindsville Limestone, Hindsville Sink Section, Madison County, Arkansas.

PETROGRAPHY

Methods. Oriented samples were collected from exposed beds at the Hindsville Sink Section. Petrographic thin sections were prepared from each sample and were point counted, by 400-500 counts, to determine vertical variations in allochemical and orthochemical constituents. The sporadic outcrop habit of the Hindsville required precise location of oriented samples and measured beds by means of alidade and plane table techniques. This method ensured the accurate construction of a measured section depicting lithologic variations determined petrographically and megascopically (Fig. 1).

Results. Several lithofacies can be recognized vertically by modal analyses of ooliths, fossil fragments and matrix.

Facies 1 (Fig. 1) consists of biopelmicrite, biomicrite and poorly washed biosparite. Skeletal grains are a common (20-40%) constituent and are predominantly crinozoan columnals and productid brachiopod valves. However, echinoderm detritus, other than columnals, and ostracods are the dominant skeletal allochems in the basal biopelmicrite. Pellets are abundant (15-20%) in the basal beds, but diminish or are absent in the less muddy lithologic units. Chert clasts and quartz grains appear to be confined to the lower two thirds of facies 1 at the Hindsville Sink Section, whereas ooliths are present in low abundances (5%) in the upper one third. The dominance of carbonate mud, particularly the high mud-to-spar ratios, provides the diagnostic characteristic for recognition of facies 1. The first major departure from mud-dominated matrix is selected as the lithofacies boundary at the Hindsville Sink Section.

Facies 2 (Fig. 1) is a succession of well washed, oolitic biosparite; well washed, skeletal oosparite; and poorly washed, oolitic, sandy biosparite. Criteria useful for identification of facies 2 are: (1) spar matrix, (2) abundant ooliths (5-40%) and (3) abraded, fragmental skeletal grains (5-30%). Vertical variations in these constituents reveal an inverse relationship of volume of ooliths to volume of skeletal allochems and lime mud matrix (Fig. 1). Skeletal grains are dominated by crinozoan columnals, brachiopods and bryozoans. Distribution of these grains is random with the exception of fenestellid bryozoans which are confined to bedding-plain surfaces in the lower part of facies 2. Structures interpreted as vertical domicile burrows also are found in the central and lower beds of facies 2. These structures produce a pitted appearance on weathered bedding-plane surfaces. Examination of polished slabs and thin sections shows a cylindrically shaped plug (5-10 mm wide; 15-30 cm long) infilled with a concentration of pyrite blebs and admixtures of grain sizes characteristic of higher beds. Pseudo-ooliths (micrite-coated grains) and micritized grains (micrite envelopes), although present in all facies, are more common in facies 2. These grains resemble recent skeletal allochems that have been micritized by endolithic algae (Bathurst, 1971).

Facies 3 is clayey, intraclast-bearing biomicrite which marks the end of Hindsville deposition at the Hindsville Sink Section. Characteristic of facies 3 is the high volume of lime mud (40%) that is present with black clay. Skeletal allochems are abundant (20%) and primarily consist of articulated and disarticulated brachiopod valves. Ooliths are uncommon (3%) and are seemingly confined to micritic intraclasts. Beds of facies 3 release a petroliferous odor upon striking and a slight black oily residue upon acidizing.

DEPOSITIONAL HISTORY

The three facies recognized suggest vertical succession from lagoonal through oolite shoal to open marine conditions on the basis of the similarity of lithologic variations at the Hindsville Sink Section to facies predicted by the theoretical model of a prograding oolite shoal (Purdy, 1964). Facies 1, as suggested by a high volume of lime mud, presence of pellets and rare ooliths, may have resulted from deposition in a lagoonal or protected area on the lee side of the prograding oolite shoal. The main body of the prograding oolite shoal is represented by the lithologic features of facies 2. This reconstruction is supported by the well washed nature of the sediment and abundant ooliths that show an inverse relationship with skeletal grains comparable with their relationship in recent oolite shoals (Purdy, 1964). Deposition on the oolite shoal was punctuated by periods of slackened sedimentation that allowed bioturbation of beds and accumulation of fenestellid bryozoans. The upper part of facies 2 shows increased mud and skeletal content which indicates decreasing energy characteristic of a depositional environment seaward of the oolite shoal. Accumulation of facies 3 below effective wave base, in a reducing environment, is suggested by high volumes of carbonate mud, terrigenous clay and oily insoluable residues. Increases in energy, possibly related to storm activity, may have produced the intraclasts and ooliths of facies 3 by redistribution of bottom sediments. Skeletal calcarenites would be predicted to be present between the oolite shoal and open marine facies; however, absence of this facies may be due to lack of control (Fig. 1).

BIOSTRATIGRAPHY

Bulk samples, weighing approximately 4 kg, from 13 horizons (Fig. 1) were processed for conodonts by the procedures of Collinson (1963). Conodont form genera recovered in this investigation support the Middle Chesterian correlations of the Hindsville by Furnish and Saunders (1971) and Thompson (1972). *Cavusgnathus*, *Ganthodus* and *Lonchodina* are the most abundant conodont elements recovered at the Hindsville Sink Section. On the basis of abundance and percentage of the platform genera *Cavusgnathus* and *Gnathodus*, ecologic controls on the distribution of the conodont-bearing organism(s) are not readily evident (Fig. 1). However, low abundance and high percentage of the form genus *Gnathodus* in the basal biopelmicrite suggest that the gnathodid-bearing conodont organism ranged into environments not generally suited to other platform genera. The greatest abundance of conodont elements is in the most oolitic bed (Fig. 1). This is unusual as other oolitic horizons in northern Arkansas (e.g. Pitkin Fm.) yield few conodonts. Abundance in this interval may be related to the postulated periods of slackened sedimentation which would allow significant accumulation of conodont skeletal elements.

CONCLUSION

Lithofacies analyses of the Hindsville Limestone in its type area permit subdivision of this unit into several facies. Allochemical and orthochemical constituents of particular importance in differentiating facies are ooliths, matrix and skeletal grains. Vertical variations in these constituents compare favorably with the predicted facies in the model of a prograding oolite shoal (Purdy, 1964).

Conodont form genera recovered suggest a Middle Chesterian correlation for the Hindsville in its type area. Ecologic controls of the distribution and abundances of conodont skeletal elements are not readily evident. However, the gnathodid-bearing conodont organism may have ranged into environments not generally suited to other conodont organisms.

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